

Mind in the Quantum Universe

Physics is Rooted in Astronomy

- Kepler's Three Laws of Planetary Motion Coupled to Galileo's Association of Gravity with *Acceleration* Led Directly to Newton's Inverse Square Law of Gravitational Force, and thence to *Physical Determinism* for Solar Dynamics.
- Extrapolation from Astronomical Scale to Terrestrial/Human Scale to Atomic Scale Led to the Notion of *Universal Physical Determinism*.
- "The Causal Closure of the Physical."

The Laws of Classical Mechanics
Leave The
Phenomenal/Experiential Aspects
of Reality Completely Out

- Classical Mechanics Deals Exclusively With ***Physical Properties***: i.e., With Mathematical Quantities Assigned To *Points In Space-Time*.
- Excluded From The Dynamics Are The **Experiential Realities** That We Describe In Psychological Terms (e.g., Our Pains, Ideas, Intentions, and Mental Efforts)!

The problem of *explaining* the **mental properties** was recognized from the outset.

- Newton: “...*to determine by what modes or actions light produceth in our minds the phantasm of **colour** is not so easie*”
- Leibniz: “*Moreover, it must be confessed that **perception** and that which depends upon it are **inexplicable** on mechanical grounds, that is to say, by means of figures and motions.*”

During The 20th Century
Classical Mechanics Was Found to be
Fundamentally Incorrect!
It Was Replaced By
Quantum Mechanics!

- QM Has Had No Empirical Failures.
- QM Brings **Phenomenal Realities** into the
Physical Dynamics in a Fundamental Way!

Phenomenal Reality is Central in Copenhagen Quantum Mechanics.

- *“In our description of nature the purpose is not to disclose the real essence of phenomena but only to track down as far as possible relations between the multifold aspects of our experience”.*

(Bohr, I, p. 18)

Phenomenal Reality is Central in Copenhagen Quantum Mechanics.

- “ *...the appropriate physical interpretation of the symbolic quantum-mechanical formalism amounts only to predictions, of determinate or statistical character, pertaining to individual phenomena appearing under conditions defined by classical physical concepts. (Bohr,II,p.64)*

Phenomenal Reality is Central in Copenhagen Quantum Mechanics.

- “The conception of the objective reality of the elementary particles has thus evaporated not into the cloud of some obscure new reality concept, but into the transparent clarity of a mathematics that represents no longer the behavior of the particle but rather **our knowledge** of this behavior.” (Heisenberg, 1958, Daedalus)

Classical Mechanics Represents
A Physical Extreme!

Copenhagen QM Represents
A Phenomenal Extreme!

- Classical Mechanics Deals Only With The *Physically Described Aspects Of Nature*, and Ignores the (Classically Inexplicable) *Phenomenal/ Experiential Realities*
- Copenhagen Quantum Mechanics is *Pragmatic*: Physical Theory Is Viewed as a Human Invention, Whose Purpose is “*to extend the range of our experience and reduce it to order*” (Bohr, I, p,1).

The Middle Way: Von Neumann's "Orthodox" Quantum Mechanics.

- It Provides A *Rationally Coherent* Putative **Ontologically Objective** Description of What is Really Going On!
- It Integrates *Phenomenal Realities* ***Dynamically*** into an Evolving, Objective, Physically Described Universe!

Von Neumann's Theory Of Measurement

- Starts From Pragmatic Copenhagen QM, Which Eschews Talk of Objective Physical Reality.
- Removes Basic Ambiguities and Arrives At A Putative **Ontologically Objective, Psycho-Physical Formulation** of QM.
- Wigner Named The vN Version
“Orthodox”.

The Copenhagen Cut

- Copenhagen QM divides the universe into a *physically described part* lying **below** a “cut”, and a *phenomenally/experientially described part* lying **above** this cut.
- The part lying *above* the Copenhagen cut includes the observer/experimenter **and his measuring devices.**
- **The part of nature lying above cut probes the part lying below the cut!**

Ambiguity in Placement of Cut

- The “device” is made up of particles and physical fields.
- So we **could** move the device to **below** the cut.
- Bohr’s Analogy: A blind man with a cane.
- Ambiguity is OK for a *Pragmatic Theory*, Insofar As It Makes *No Practical Difference*.

Von Neumann's Tower of Devices.

- Consider a tower of devices such that each device measures the *output* of the device below it.
- Extend this tower into the brains of the observers.
- Ultimately the entire world of things that are described in terms of particles and fields, *including all brains*, is pushed **below** the final **unambiguous** (von Neumann) placement of the cut.
- **Above** the von Neumann cut **remains** all of the experiential realities: our experiences of shape and color, our pains, joys, sorrows, appetites, satisfactions, intentions, conscious efforts, values, meanings, predictions, etc.

Von Neumann's Mathematical Conclusion.

- Shifting the cut from an original *ambiguous* “Copenhagen placement” to the final *unambiguous* “von Neumann placement” does not alter the *predictions of quantum mechanics*, which reside in the realm of experiential realities that lie above every cut.

An Essential Difference Between CM and QM

- In Classical Mechanics (CM) **everything**, both above and below the cut, **is assumed to be** controlled by the purely dynamical laws of classical mechanics.
- So when one pushes the cut up to the von Neumann placement, nothing of dynamical relevance remains above the cut.
- But for QM the phenomenal realities remain!
- They **can be** dynamically relevant, because in QM our phenomenally described **Probing Actions** have **Significant Dynamical Effects** upon the physically described aspects of nature that they are probing.

The Mind-Brain Connection

- The mind-brain connection is the connection between what lies **above** the von Neumann cut and what lies in **brains**, which lie **below** the von Neumann cut.
- Understanding this mind-brain connection is central to understanding the ontological conception of nature offered by orthodox quantum mechanics.

The Basic Conceptual Problem

The Evolution of the Quantum State via the Schroedinger **Wave** Equation *Causes* a (**Wave-Like**) Quantum State That Is Initially Concordant with All Human Experience to Develop into State that Corresponds a **Continuous Plenum** of Alternative Possible Worlds of the Kind that we Actually Experience.

The Problem Is This: **How Is The Lost Connection To Human Experience Usefully Re-Established?**

Von Neumann Identifies Two Key Components of the Quantum Dynamics: Process 1 and Process 2

- Process 1 is an action that divides the current Quantum State of the Universe into a part that is compatible with a particular possible experience, and the complementary part that is not.
- This process-1 action **logically precedes** a **random choice** between the two options that this process-1 action defines.
- Process 2 is the (Schroedinger) Evolution of the Quantum State. It Holds ***Between*** the Instantaneous Process-1 Related **Reduction Events**.

Heisenberg's Invocation of the Aristotelian Ideas of "Potentia" and "Actual".

- The Quantum State is considered to be Objectively Real.
- But Its Ontological Character is that of a "**Potentia**", or "**Objective Tendency**", for an *Actual Event* to Occur.
- An "Actual Event" Is an *Objectively Real* **Psycho-Physical Event** that ***Reduces*** the physically described quantum state to one or the other of the two **Process-1 created options**.

The “Orthodox” (von Neumann-Heisenberg) Ontology

- The “Actual World” Consists of a *Well-Ordered* Sequence of Psycho-Physical **Actual Events**.
- The Universe Manifests *Objective Tendencies* for Actual Events to Occur. These *Tendencies* Inhere in the Quantum State of the Universe.
- Each Actual Event **Reduces** the Quantum State to One of the Two Options Specified by a Process -1 Action.
- The Quantum State Evolves Deterministically, via The Schroedinger Equation, ***Between*** these Actual Reduction Events.

The Causal Gap

- This von Neumann-based ontology provides a rationally coherent conception of what is really going on in Nature.
- Each process-1 action specifies a particular connection between the physical and phenomenal realms.
- But the ***causal roots*** of these Process-1 actions are not specified by the currently known laws!

Causally Effective Human Free Choices

- *“The freedom of experimentation...is fully retained and corresponds to the free choice of experimental arrangement for which the quantum mechanical formalism offers the appropriate latitude.”*

(Bohr, II, p.73)

Appropriate Latitude ~ Causal Gap

- A Causal Gap In Our **Currently Known** Laws. (Science Not Yet Complete)

QM Allows Evolution of Mind-Brain System via Natural Selection

- Nothing Can Evolve Via Natural Selection Unless It Has Causal Consequences!
- Evolutionary Development of Mind Would be Blocked By Causal Closure Of The Physical!
- Most Non-Orthodox Non-Copenhagen Versions of QM (Many-Worlds, Bohmian Pilot-Wave, GRW Random Collapse) Keep Consciousness Causally Inert.
- Orthodox QM Allows Consciousness To Evolve In Step With The Brain By Natural Selection
- Why Favor Inert Consciousness? Simplicity.

How Conscious Intentional Effort Can Tend To Produce An Intended Physical Effect

- A “Template For Action” Is A Pattern of Brain Activity Which, If Sustained, Tends To Cause The Associated Intended Physical Action To Occur.
- *Assume* That Conscious Effort Can Increase The Rapidity At Which The Corresponding Process-1 Probing Actions Occurs.
- Then onscious Effort Can Activate The “Quantum Zeno Effect”, Which Can Tend To Hold The Template For Action In Place.
- Thus Conscious Effort Can Tends To Cause The Intended Physical Action To Occur.

Concordance With William James

- “I have spoken as if our attention were wholly determined by neural conditions. I believe that the array of things we can attend to is so determined. No object can catch our attention except by the neural machinery. But the amount of the attention which an object receives after it has caught our attention is another question. It often takes effort to keep mind upon it.”

William James Continued

- “We feel that we can make more or less of the effort as we choose. If this feeling be not deceptive, if our effort be a spiritual force, and an indeterminate one, then of course it contributes coequally with the cerebral conditions to the result. Though it introduce no new idea, it will deepen and prolong the stay in consciousness of innumerable ideas which else would fade more quickly away.”

- According to James, holding the idea of an action in place, in conjunction with a *consent* to let the action happen, will cause the body to *move to make the phenomena match the idea*.
- *Orthodox QM explains how this can happen.*

Beyond Human Experience

- So Far We Have Been Considering Von Neumann's Ontologicalization of Copenhagen QM, which focused on Human Experience.

Do Collapse Events Occur ONLY In Conjunction With Human-Type Consciousness?

- Von Neumann: Collapse Events NEED Occur Only In Conjunction With Human Conscious Experiences.
- But They COULD Occur ALSO At The Macroscopic Measuring Devices, Without Appreciably Affecting The Predictions Of Orthodox Quantum Mechanics!

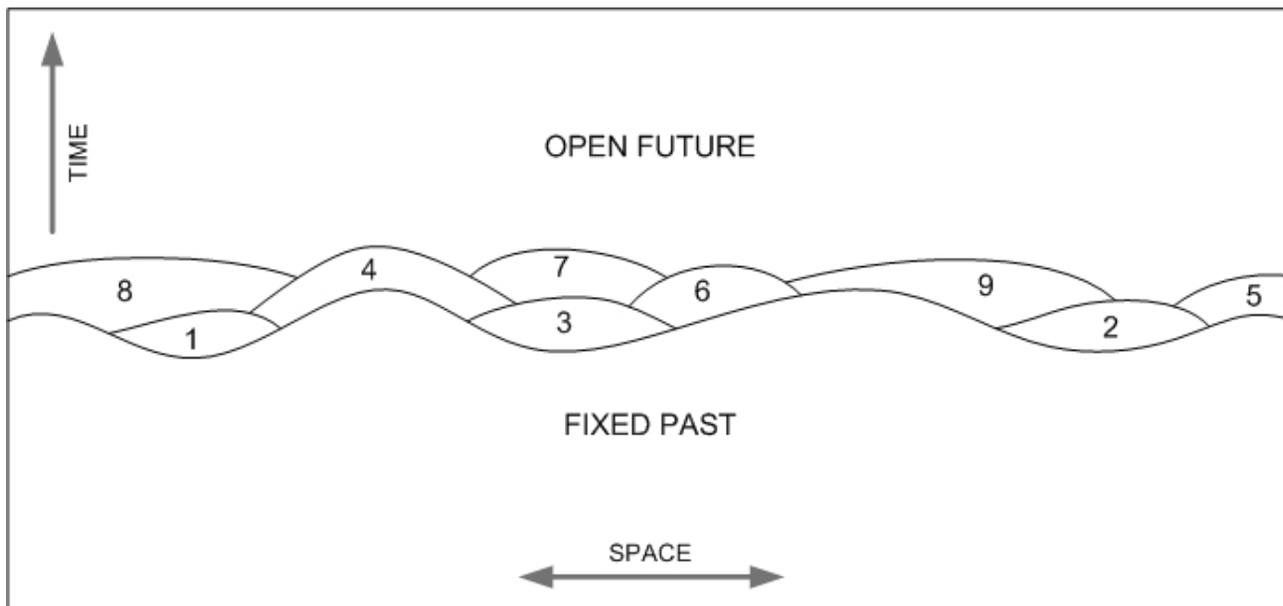
Are Collapse Events General?

- There Is No *Empirical Evidence* For Collapses Beyond Those Associated With Human Consciousness.
- But, Philosophically, It Seems Extremely Unlikely That Something So Profoundly Effective As These Collapse Events Could Come Into Existence Only In Association With Human Beings, Or Even With Life In General.
- If Collapse Events Exist At All, They Are “Most Naturally” A General Feature of Nature That, **In Association With The Emergence of Living Species**, Evolved By Natural Selection In A Way That Led Eventually, In Human Beings, To The Consciousness We Know.

Consequences For Astronomy

- If Collapse Events Are A General Feature Of Nature, And Have Occurred On The Astronomical Scale, Then We Must Expect The Observed Universe To Exhibit Structural Features That Are Inexplicable In Terms Of A Purely Physical Process Acting Alone, But That Indicate The Presence Of A Dynamical Input Of A **Conceptual Process**, that acts within the realm of the quantum uncertainties.
- The Presence Of Such A Structure Would Be Contrary To The Precepts Of Classical Mechanics, But Not To The Precepts Of Orthodox Quantum Mechanics.
- Science-Based Astronomy Is Not Bound, Even On The Cosmological Scale, By The Strictures Of Classical Mechanics. The Dynamics Could Be In Part Conceptual.

Compatibility With Relativistic Quantum Field Theory



Relativity

- In Non-Relativistic Quantum Theory The Quantum State Of The Universe Represents What Exists Physically At **An Instant Of Time Over All Of Space.**
- In The Tomonaga-Schwinger Generalization To Relativistic Quantum Field Theory The Quantum State Represents What Exists Physically **On A Space-Like Surface.**

Serial Advance Into The Future

- In RQFT The Advance Into The Future Can Occur In A Well-Ordered Sequence Of Small Localized Advances.
- It Can Be Shown That The Process-1 Action In One Localized Place Has No Effect At Other Places Along The Space-Like Surface. But The **Selection Of An Option** Does Have Far-Away Effects, Yet No Violation Of The *Physical Requirements* Of Relativity: No FTL *Signaling*, and All *Predictions* Are Independent Of Ordering Of Space-Like Separated Events.